PATENT SPECIFICATION (11) 1 515 390

1 515 390

(21) Application No. 35003/75 (22) Filed 22 Aug. 1975
(31) Convention Application Nos 500 131 and 499 961
(32) Filed 23 Aug. 1974 in
(33) United States of America (US)
(44) Complete Specification published 21 June 1978
(51) INT CL² H01M 2/10; A01G 3/06//B23B 45/04; B23K 3/02; B24B 23/02; B27B 19/02; F21L 7/00
(52) Index at acceptance
H1B 210 210A
A1F 6J4 H22
B3C 1A8H1
B3D 1D1 2A15
B3R 22E1
B5L 4
F4R 244 24X 254 275 27Y 41Y 466 507 512

(19)

(54) BATTERY-OPERATED ELECTRICAL APPLIANCE OF MODULAR CONSTRUCTION

(71) We, THE BLACK AND DECKER MANUFACTURING COMPANY, a Corporation organized under the laws of the State of Maryland, United States of America, of Towson, Maryland, 21204, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a battery-operated electrical appliance of modular construction.

According to the invention there is provided a first module in combination with a second module, the first module comprising a housing having an end abutment face, a hard grip, a cavity for receiving battery means, terminals for making electrical contact with the battery means when positioned within the housing, first contact means accessible from outside the first housing and a control switch in electrical connection in a circuit including the first contact means and the terminals, and the second module comprising a housing incorporating an electrical appliance and with an end abutment face adapted to mate with the end abutment face of the first module by means of slidably interlocking surfaces on the end abutment faces to hold the modules together and second contact means accessible from outside the second housing, in electrical connection with the electrical appliance and positioned to engage the first contact means electrically when the first and second housings are in mating engagement, the arrangement being such that mating of the end abutment faces is effected by engaging the end abutment faces and then sliding one module relatively to the other in a direction substantially parallel to the end abutment faces thereby engaging the slidably interlocking surfaces.

According to another aspect of the invention there is provided a power handle module comprising a housing having an end abutment face adapted to mate with an end abutment face of a module incorporating an electrical appliance, a cavity for receiving battery means, terminals for making electrical contact with the battery means when positioned within the housing, contact means accessible from outside the housing for engaging contact means on an electrical appliance module when it mates with the power handle module and a control switch in electrical connection in a circuit including the first contact means and the terminals, wherein the end abutment face of the power handle module is provided with a slidably interlockable surface, the arrangement being such that mating of the end abutment face of the power handle module to an electrical appliance module is effected by engaging the slidably interlockable surface of the power handle module with a corresponding surface on an end abutment face of an electrical appliance module and then sliding one module relative to the other in a direction substantially parallel to the end abutment faces.

According to another aspect of the invention there is provided an electrical appliance module comprising a housing incorporating an electrical appliance and having an end abutment face adapted to mate with an end abutment face of a power

handle module, and contact means in electrical connection with the electrical appliance and accessible from outside the housing for engaging contact means on a power handle module when it mates with the electrical appliance module, wherein the end abutment face of the electrical appliance module is provided with a slidably interlockable surface, the arrangement being such that mating of the end abutment face of the electrical appliance module to a power handle module is effected by engaging the slidably interlockable surface of the electrical appliance module with a corresponding surface on an end abutment face of a power handle module and then sliding one module relative to the other in a direction substantially parallel to the end abutment faces.

The modular construction permits the utilisation of individual tool heads (the second module), each of which incorporates its own essential elements such as a motor and a driven blade or chuck as its output means and any required gear train, etc. Thus, each individual tool head includes only those components which are individually tailored to the particular output required. The other basic modular section (the first module) includes the elements which are appropriately universal that is to say the first module is a power handle which includes a functional hand grip, battery means and a switch. As the power handle and each tool head include cooperating mechanical means, they afford quick, highly stable connection and disconnection. Moreover, each module is provided with suitable electrical contact means which electrically engage upon mechanical connection of the modules. Furthermore, the second module may be a battery recharging head constructed in a similar manner to each of the individual tool heads so that the power handle can be connected thereto in a similar manner for recharging of the battery.

The resulting system enables the users to obtain, in an optimum fashion, the cost and convenience benefits of a single, universal power handle and at the same time, the performance benefits of individualised design of those elements which directly cooperate with the output of a particular tool head. In addition, this system minimises space requirements for storage and maximises the life span of each motor. By way of example, certain motor gear train and output means combinations may require very high power, short duration usage, others may require reversing capability, while still others may require long term, relatively low torque output. In each case, a tool head may be designed to meet the specific requirement without the necessity of compromise to meet alternative, or contradictory, requirements. It should also be noted that the individual tool heads can be stored between use with greater safety since they can become operational only upon proper connection to the power handle, which requires a positive and intentional act.

Another advantage of the system is the fact that it permits improved utilisation of the nickel-cadmium batteries and the charger which are usually used for such devices and which are particularly high cost elements. Such batteries should be used frequently rather than allowed to remain on charge for long periods. Thus, providing specific battery-charger combinations for each of a variety of individual tools is not only more costly but also harmful to the batteries and inefficient with regard to the chargers. This modular system eliminates this extra cost and substantially increases the life expectancy of the batteries.

A further advantage of the modular system, in contrast to conventional, integral tools, is that is provides the user with the option of quickly and conveniently substituting an alternative battery handle in the event that his job exceeds the capacity of one set of batteries. Conventional tools, on the other hand, would require the user to interrupt the job until the internal batteries could be recharged. With the present system, the battery handles can be easily transferred from the charger to the head to allow the job to be completed.

Several forms of modular tools, each constructed in accordance with the invention, will now be described, by way of example, with reference to the accompanying drawings, in which:—

Figure 1 is a perspective view of the first form of modular tool;

Figure 2 is a view of the tool of Figure 1 showing the two modules separated;

Figure 3 is a side elevation, partially in cross-section, showing the internal construction of the tool of Figs. 1 and 2;

Figure 4 is a view similar to that of Figure 3 but showing the two module elements at an intermediate point during the assembly thereof;

Figure 5 is a cross-section taken on the line 5—5 of Figure 3;

Figure 6 is a perspective view showing the power handle module of Figure 1 mounted on a charging stand;

Figure 7 is a side elevation showing the assembly of the power handle

module to the charging stand of Figure 6;

Figures 8 to 13 are perspective views illustrating the assembly of the power handle module to a variety of alternative tool head modules;

Figure 14 is a perspective view of the second form of modular tool;

Figure 15 is a side plan view of the power handle module of Fig. 14, partially broken away and partially in section;

Figure 16 is a view similar to Fig. 15 but taken of the tool head module of Fig. 14;

Figures 17 and 18 are respectively front and rear elevations of the power handle module and the tool head module of Fig. 14;

Figure 19 is a cross-section taken on the line 19—19 of Fig. 15 and also shows a perspective view of the trigger and switch assembly;

Figure 20 is a perspective view of a modified form of the tool of Fig. 14;

Figures 21, 22 and 23 are detailed views showing the assembly of the tool of Fig. 20;

Figure 24 is a schematic view showing the circuit used in the power tool of Fig. 20:

Figure 25 is a perspective view of a charging module for use with the tools of Figs. 14 and 20; and

Figure 26 is a side elevation partially in section, showing an extension module for use with the tool of Fig. 14.

Referring to the drawings, Figures 1—5 show a portable, hand-held, cordless electric tool, indicated generally by the reference numeral 10 (Figure 1), which includes a power handle 12 detachably secured to a tool head 14. As used herein, the term "tool head" should be understood to mean a housing including output means such as a moving blade or shaft, or a static soldering tip or light, and further including a drive train and electric motor combination, if appropriate. The handle 12 encloses one or more rechargeable battery cells 11, and is provided with a control switch 13, operated by a trigger 16 which is conveniently located for operator actuation when his hand is in place on the handle. In the illustrated device, the tool head 14 encloses a suitable D. C. motor 18 which is drivingly connected through a transmission 20 to a trimmer blade assembly 22.

The power handle 12 and the tool head 14 are constructed for mechanical interconnection and simultaneous electrical interconnection whereby the batteries 11 power the motor 18 under the control of the switch 13. To accomplish this interconnection, the power handle 12 includes a dovetail mortise 24 which is adapted to slidably interfit with a dovetail tenon 26 formed on the adjacent face of the tool head 14. The external housings of the power handle 12 and the tool head 14 are shaped in complementary fashion so that in the assembled tool the two parts form a smooth external configuration (see Fig. 1). To complete the mechanical interconnection, a latch button 28 is provided in the upper surface of the power handle 12, which button is biased in a forward direction by a spring 30, and the tool head 14 is provided with a slot 32 for receiving the leading end of the button when the two units are in the assembled position. Thus, the units can be assembled by withdrawing the latch button 28 out of the way of the tool head 14, sliding the tenon 26 into the mortise 24 and allowing the latch button 28 to enter the slot 32 when the two modular portions are properly aligned (see Fig. 4). The mortise 24 and tenon 26 are provided in pilot surfaces 34 and 36 respectively. These pilot surfaces maintain the two modular portions of the tool in a stable, accurate alignment as they extend substantially across the entire width of the tool.

The motor 18 is supported upon a spacer 38 and a mounting plate 40, to which the blade assembly 22 is affixed by screws 42. The spacer 38 includes a pair of plugs 44 and 46 which are electrically connected by conductors 48 and 50 to the motor 18. As shown, the plugs 44 and 46 extend externally of the tool head 14 in a position to interfit with a complementary pair of plugs 52 and 54 carried by a support 56 which extends forwardly form the pilot surface 34 of the power handle 12. The plugs 52 and 54 are internally connected by wires 58 and 60 to the switch 13 and the batteries 11.

When the power handle 12 and the tool head 14 are assembled by sliding the tenon 26 into the mortise 24 until the tool head is fully seated against the power handle 12 (see Fig. 3), the plugs 44 and 46 are interfitted with the corresponding plugs 52 and 54 and the latch member 28 extends into the slot 32 to prevent accidental uncoupling.

This tool also incorporates a safety element for preventing injury which might otherwise occur during the assembly of the power handle 12 and the tool head 14. Specifically, in engaging and uniting the power handle 12 with the tool head 14, it is possible for a careless operator to inadvertently place one hand in contact with the blade assembly 22 and the other hand in contact with the trigger 16. If this is

done, as soon as adequate electrical contact is made between the plugs 44, 46 and 52, 54, the blade assembly may be activated and cause injury. In order to avoid this possibility this tool includes a lock-off arrangement comprising a pivoted lever 62 which prevents movement of a button 64 fast to the on-off switch 13 until the lever is transversely moved out of the way. An operating button 66 is provided for moving the lever 62 out of the path of the button 64 after the tool has been properly assembled.

The button 66 is positioned within and essentially coplanar with the exterior surface of the power handle 12. Thus, regardless of the position of the operator's hand during assembly of the two modules, it is highly unlikely that he will be able to move the button 66 away from its lock-off position unless he deliberately intends to do so. The lever 62 is preferably spring biased towards the off position by the latch spring 30 and the trigger 16 is also biased to its off position about its pivot point 68. Thus, when the handle is released, the trigger 16 pivots to the off position and the lever 62 pivots to the engaged position (see Fig. 3). Accordingly, in any normal assembly of the power handle 12 to the tool head 14, inadvertent actuation of the output means is prevented.

The power handle 12 can be connected to a variety of different tool heads, each of which embodies the same simple, but highly stable interconnection means as the tool head 14. The power handle 12 can also easily be connected to a charger for recharging the enclosed battery cells 11. In this regard, Figure 6 illustrates the power handle 12 installed in place on a recharging stand 70 and Figure 7 illustrates the assembly of these two modules. Conveniently, the recharging stand 70 includes a pedestal 72 and, for proper interfit with the power handle 12, the charger includes a pair of plugs 74 and 76 which are identical to the plugs 44 and 46 provided in the tool head 14. Alternatively, an additional connection engaged by a slightly different, or differently located, plug may be provided so that charging can be accomplished through a circuit which bypasses the switch 13.

The upper surface of the charger 70 includes a dovetail tenon 78 and a pilot surface 80 which interact with the mortise 24 and the pilot surface 34 in the same manner as the corresponding parts of the tool head 14. The charger 70 is also provided with an electrical power cord 82 which terminates in a male plug 84 conventionally adapted for connection to a house current outlet 86. The charger 70 also includes an indicator light 88 for communicating some aspect of the condition of charge to a user. Thus, upon completion of use of the power handle 12 with a particular tool head, the power handle is removed from the tool head and assembled to the battery charger 70, for recharging of the enclosed batteries 11. At the same time, this provides for convenient and safe storage of the power handle 12. The removal of the tool head, required by this recharging arrangement, also avoids the possibility that inadvertent actuation of the tool head, for example by a child, might cause injury.

To illustrate the interchangability of the power handle 12, Figure 8 shows the power handle as connected to a soldering iron head 90 which includes a pair of electrical conductors 92 and 94 extending forwardly of the head and connected to a tip 96. The rear portion of the soldering iron head 90 includes tenon and plug means (not shown) which are substantially identical to those provided on the charger 70 and on the grass shear head 14 for mechanical and electrical connection to the mortise 24 and the plugs 52 and 54 of the handle 12. Thus, when the power handle 12 is coupled to the soldering iron head 90, heating of the soldering tip 96 is controlled by the switch 16. If desired, thermostatic control means or other suitable circuitry may be included within the soldering iron head 90.

Figure 9 shows the power handle 12 interconnected, in a similar manner to that previously described, with a drill head 100. In this instance, the mechanical and electrical connections are the same as those previously illustrated and the drill head 100 includes a suitable electric motor and power train (not shown). In terms of general construction and mounting, these may be basically similar to the motor 18 and the power train 20 previously described for the grass shear head 14. However, because of the difference in uses to which the grass shear and drill are respectively applied, there is a significant difference between the requirements for the motor-gear train of a drill as compared to those for the motor-power train of a grass shear. Accordingly, owing to the separation of the power supply and output functions provided by the two module construction, the respective motor-power train combinations may be individually designed to its best advantage to accomplish the particular purpose of each individual tool head, in contrast to the wide variety of output head accessories previously necessary for conventional power tools. At the same time, this is accomplished without unnecessary duplication of the parts included in the power handle 12.

In a similar manner, Figures 11, 12 and 13 illustrate alternative interconnections of the power handle 12 to other alternative tool heads. Figure 11, for example, shows a jig

saw head 104 including a reciprocating output shaft 106 coupled to a suitable blade 108 which extends through a supporting shoe plate 110. Figure 12 shows a flashlight head 112 including a lens 114 behind which is mounted a suitable light bulb (not shown). Figure 13 shows the power handle 12 in association with a grinder head 116 from which extends a rotary output shaft 118 on which is mounted a small grinding wheel 120.

Figure 10 illustrates an alternative form of battery charger having a charger stand 122 which includes tenon and plug means (not shown) at one end which means are adapted to receive the power handle 12 in the same manner as previously described. The stand 122 further includes, at its other end, a region such as a pocketed compartment for convenient reception and storage of a tool head such as the grass trimmer head 14 shown in Figure 1.

Referring now to Figs. 14 to 20, there is shown a portable hand-held, cordless electric tool 10' which includes a power handle 12' (shown in detail in Figs. 15 and 17), detachably secured to a tool head 14' (shown in detail in Figs. 16 and 18). In the illustration of Fig. 14, the tool head 14' includes battery-operable means for driving a grass shear blade assembly 16' which is energisable by means of batteries included in the handle 12' under the control of a trigger 18'.

As shown in Figs. 15 and 17, the power handle module 12' includes a pair of clamshell half housings 20' and 22'. A plurality of battery cells 24' and 26' are provided within the power handle module 12'. These cells 24' and 26' are connected in series at one end by a conductor 28' and are connected at their other ends by conductors 30' and 32' to a pair of exposed electrical contacts 34' and 36' (see Fig. 17).

The power handle module 12' is a four-sided member with a central aperture which provides a convenient hand grip portion and which contains internally the battery cells 24' and 26' (see Fig. 15). The trigger member 18' is retained within a switch housing 38 positioned between the clamshell halves 20' and 22', and is spring biased downwardly against retaining surfaces provided in the switch housing by a spring 42'. For lock-off purposes, that is to say for preventing accidental operation of the tool 10', the trigger 18' is provided with an internal shoulder 44' which cooperates with one end of a lock-off lever 46', the lever being provided at its other end with a thumb-engageable button 48'. A rearward extension 50' of the lock-off lever 46' engages one end of the spring 42' and the lever is fixedly mounted within the module at a pivot point 52'.

The function of the spring 42' is to bias the trigger 18' to its off position and simultaneously to bias the lock-off lever 46' to its engaged position. Thus, in the position shown in Fig. 15, if the operator attempts to move the trigger 18' inwardly, the shoulder 44' will engage the end of the lock-off lever 46' and further movement of the trigger is prevented. Before the operator can turn the tool 10' on he is required to pivot the lock-off lever 46' by means of the button 48' so that the shoulder 44' bypasses the end of the lock-off lever when he engages and moves the trigger 18'. Thus, because of this requirement, the likelihood that the trigger 18' can be accidentally engaged is greatly reduced. This is a particular advantage, for example, when the operator is assembling a tool head, such as that shown in Fig. 14, to the power handle 12' since otherwise, accidental energisation of the grass shear assembly 16' could cause serious injury.

A small tapered shoulder 54' is provided on the lower end of the lock-off lever 46', which shoulder permits relaxation of the trigger 18' so as to turn the tool 10' off and yet not release the trigger so far that the lock-off lever 46' engages the trigger. Maintaining the trigger 18' in such an intermediate position is usually awkward for an operator since this is an undefined position and he must exert a conscious effort to maintain his finger at exactly the right position relative to the handle to avoid either turning the device on or allowing it to be locked off. The tapered shoulder 54' avoids this awkwardness by providing a stop or detent position at which level the tool 10' is off but at which the lock-off lever 46' is disengaged. Since the shoulder 54' provides some resistance, the operator can easily hold that position but, when he wishes to turn the tool 10' on, he can easily overcome the small resistance because of the taper provided on the shoulder.

The tool head module 14' includes an electric motor 56' which is connected by wires 58' and 60' to suitable contacts 62' and 64' which are arranged to be connected to the batteries 24' and 26' as will be hereinafter explained. The motor 56' includes an output shaft 66' which drives a gear 68' and an eccentric 70' which ultimately produces reciprocation of one of the blades of the grass shear assembly 16'.

Figs. 17 and 18 illustrate the mechanical and electrical connection system of the handle module 12' and the tool module 14'. The power handle module 12' includes at its forward end an interconnection member 72' (see Fig. 17) which includes a pair of ribs 74' and 76' which are of increasing width both from side-to-side and from front-to-back relative to the handle module. The member 72' also includes a plurality of forwardly

extending insulating ribs 78' and 80' which separate and protect the contacts 34' and 36' and an additional, intermediate contact 35'. Adjacent the bottom of the forward end of the power handle module 12', a latch 82' is provided which is pivotally mounted adjacent the bottom of the ribs 78' and which has a tapered forward surface 84' extending downwardly therefrom. The latch 82' is spring biased outwardly about its pivot point by an internal spring (not shown).

The rear portion of the tool head module 14' includes a complementary mounting member 86' (see Fig. 18). Extending along the sides of the mounting member 86' are a pair of ribs 88' and 90' having internal tracks 92' and 94' which are tapered complementarily to the ribs 74' and 76' on the power handle module 12'. Thus, to assemble the modules 12' and 14', the ribs 74' and 76' are engaged respectively in the tracks 92' and 94' and the modules are pushed together until the tracks and ribs are fully engaged which occurs when the upper surface of the member 72' encounters a pair of stops 96' on the mounting member 86'. To maintain the members 72' and 96' in engagement, a small ledge 98' is provided at the bottom of the member 86'. The ledge 98' moves the latch 82' out of the way by virtue of the tapered surface 84' and engages under the bottom edge of the latch to retain the modules 12' and 14' in the assembled condition until the operator disengages the latch.

During the mechanical assembly of the modules 12' and 14' as just described, the electrical contacts 62' and 64' of the module 14' engage and slide along the spring contacts 35' and 36' on the power handle module 12'. This construction achieves not only electrical contact but also results in a wiping action to help overcome any build-up of corrosion on the contacts which might otherwise prevent proper electrical continuity.

Fig. 19 illustrates the electrical arrangement and switch mechanism of the tool 10'. As previously noted, the batteries 24' and 26' are directly connected by wires 30' and 32' to the spring contacts 34' and 36'. As can be seen in Fig. 19, this connection is accomplished by means of push-on terminals 100' and 102' which engage respectively flag portions 104' and 106' of the terminals 34' and 36'. As also can be seen in Figs. 15 and 19, the upper ends of the terminals 34', 35' and 36' are extended inwardly of the mounting member 72' through slots 73' formed therein and are provided with flat upper portions 108', 109' and 110' which lie against the internal surface of the mounting member 72. The contacts are retained in place by small spring tab 111'. Thus, the battery cells 24' and 26' are permanently connected to the contacts 34' and 36' and therefore to the internal contact portions 108' and 110'. As illustrated schematically in Fig. 19, the motor 56' is connected by wires 58' and 60' and the contacts 62' and 64' to the contacts 35' and 36'.

To provide for energisation of the motor 56', a switch is provided to connect the upper portion 108' of the contact 34' to the upper portion 109' of the contact 35'. This is accomplished by means of a metal spring contact member 112' which is mounted on a suitable rib 114' on the front end of the trigger 18' (see Fig. 19). In the "off" position of the trigger 18' (see Fig. 15) the spring 42' biases the trigger downwardly so that the contact member 112' rests against the insulating inner surface of the mounting member 72'. When the lever 46' is disengaged and the trigger 18' is moved to the upper position against the force of the spring 42', the contact member 112' is moved into engagement with contact portions 108' and 109', thus completing electrical connection thereof. Thus, the motor 56' is energised by virtue of its connection through wires 58' and 60' to the contacts 62' and, 64' which are engaged with the contacts 35' and 36'. The contact 35' is switched into connection with the contact 34' and the batteries 24' and 26' are connected permanently in series between the contacts 34' and 36' to complete the circuit.

Fig. 19 also illustrates the electrical interconnection of the handle module 12' to a charger having a charger circuit provided in a housing which includes interconnection means, substantially identical to those provided on the tool head 14', so that the charger housing connects to the power handle module in the same manner. A transformer (the secondary winding 116' of which can be seen in Fig. 19) and a diode 118' are provided within the charger housing. The charger housing also includes contacts illustrated schematically by arrows 120' and 122', these contacts being positioned to engage the contacts 34' and 36' of the power handle module 12'. Since the batteries 24' and 26' are permanently connected to the contacts 34' and 36', the charger circuit is completed as soon as the modules are assembled and there is no need for the operator to engage the trigger in order to complete a charging circuit.

A particular advantage of the embodiment of Figs. 14 to 20 lies in the provision of a switch which simply requires the addition of the spring metal contact 112' to the trigger 18' and the contact portions 108', 109' and 110' which would be required regardless of what type switching mechanism might be provided. This

simplified construction completely eliminates several additional parts and the interconnection steps which would normally be required, thus reducing the size, weight and cost of the tool and eliminating parts which might lead to failure, for example, that due to lead breakage.

To mount the spring contact 112' on the switch rib 114', the spring contact is provided with a T-shaped slot 113' and the rib 114' is provided with a corresponding cross-head 115'. Co-operation between the T-slot 113' and the cross-head 115' extending transversely to the direction to the movement of the trigger 18' positively locates the spring contact 112' relative to the trigger and eliminates relative motion which might otherwise be present and which might cause difficulty in closing the circuit.

Another advantage of this embodiment lies in the provision of an angular relationship between the mechanical mounting means by which the respective modulus 12' and 14' are engaged and the mating edges of the external housings of the modules. If these respective engaging surfaces were arranged in parallel, interference between the matching housing surfaces could occur as soon as the two modules and their mounting members are positioned for assembly. Depending on the tolerances of the respective parts, which frequently presents a difficulty in housings made of low cost plastics materials, binding could occur or alternatively an unsightly gap might be left which could admit dirt or moisture to the electrical contact area.

The difficulties caused by such parallelism can be reduced by providing an angle between the leading edges of the respective housings, illustrated by the dotted lines 124' and 126' (see Figs. 15 and 16) and the plane of the mounting parts, illustrated by the dotted lines 128' and 130'. Because of this angle, which may be in the range of from 4° to 7° although this is not critical, initial engagement of the mounting parts occurs while the housing edges are still relatively widely spaced. As the mounting members are moved into their assembled relationship, the gap between the juxtaposed housings becomes less and less until, in the completely assembled position, the housings meet to complete the enclosure of the tool 10'. This aspect of this embodiment is illustrated in Figs. 21 to 23 wherein the gap between the leading edges of the housings 124' and 126' decreases as the respective modules are moved toward the assembled position.

Figs. 21 and 23 also illustrate an arrangement for use with certain selected tool head modules and in which no safety hazard is caused if the trigger 18' should be turned on accidentally. For example, Fig. 20 illustrates a flashlight including the power handle module 12' coupled with a flashlight head 132'. The flashlight head 132' includes a suitable lamp having a lens 134' and a filament 136' adapted to be operated from the batteries 24' and 26' in the power handle 12'. Since no safety hazard can be occasioned by accidental operation of the trigger 18', the rear portion of the housing of the flashlight head 132' includes means for automatically disengaging the lock-off button 48' of the power handle module 12'. Specifically, as shown in Figs. 21 to 23, a rearward extension 140' of the housing is positioned to engage the lock-off button 48'. The underside of the extension 140' includes a tapered camming surface 143'. As the respective modules 12' and 132' are moved into their assembled position, the tapered camming surface 143' engages the forward edge of the lock-off button 48' and cams it rearwardly to disengage the end of the lock-off lever 46' from the shoulder 44' of the trigger 18'. Thereafter, the operator can activate the flashlight by simply moving the trigger 18' without the necessity of having to first release the lock-off lever 46'.

A particular advantage of the flashlight illustrated in Fig. 20, which is permitted by the specific electrical arrangement described previously, lies in the fact that, while the power handle 12' has a very simple switch which is actuated "on" as long as the operator physically holds it in the "on" position, to avoid excessive battery drain (which might occur if a high drain power head module were left switched on when not actually in use), the multiple contact arrangement permits devices such as the flashlight to have a continuous duty switch such as that shown at 138'. Thus the flashlight module 132' includes three terminals 142', 144' and 146' (see Fig. 24) which respectively engage the contacts 34', 35' and 36' on the power handle 12'. Accordingly, when the flashlight module 132' is assembled to the power handle 12', closure of the switch 112' by means of the trigger 18' causes momentary operation of the flashlight until the trigger is released. If continuous operation is required, the switch 138' is closed so that the flashlight is "on" without the operator being required to continuously hold the trigger 18'. On the other hand, as previously noted, high drain devices such as those having motors cannot be "locked-on" since the power handle module 12' is not provided with this feature.

As previously noted, the power handle module 12' is adapted to be recharged by interconnection with a charger module which includes a mounting arrangement

similar to that of the tool head 14'. Thus, as shown in Fig. 25, a power head module 150' is provided with a rear mounting structure similar to that shown in Fig. 18. In this case, of course, terminals 64' and 154' are provided to engage the contacts 34' and 36' so that the switch is bypassed and charging occurs even though the switch is off. A cord set 156' is provided for connection to a suitable source of power. Internally, any of a wide variety of charging circuits may be provided such as the conventional transformer/diode combination.

The hand-held grass-shear unit of Fig. 14 can, when desired, be provided with an intermediate extension module positioned between the modules 12' and 14' to provide a stand-up, wheeled unit. This arrangement is illustrated in Fig. 26 wherein the power handle module 12' and the tool head module 14', indicated schematically, are separated by an extension handle module 160'. The extension handle module 160' includes an elongated tube 170' of suitable length which encloses a pair of conductors 172' and 174'. A housing 176' at the upper end of the tube 170' encloses a mounting member 178' which corresponds to the member 86' shown in Fig. 18. A pair of contacts, one of which is shown at 180', extends through the mounting member 178' to make appropriate electrical contact with the contacts on the face of the power handle module 12'. Similarly, a pair of ribs, one of which is shown at 182', are provided to mechanically engage with the corresponding ribs on the power handle module 12'.

At the lower end of the tube 170', a second housing 184' is provided which includes a mounting member 186' which corresponds to that shown at 72' in Fig. 17. The contacts and mechanical structure associated with the member 186' correspond to those associated with the member 72'. A pair of wheels 188' are also provided and mounted to the housing 184' by an axle 190'. Accordingly, the extension handle module 160' is adapted to receive the power handle module 12' at one end and the tool head module 14' at the other so that a stand-up grass shear can readily be assembled when desired.

A significant increase in the life of rechargeable batteries of the nickel-cadmium type can be obtained by utilising the batteries frequently so that they are subjected to discharge and charge cycles more often. In the conventional type of cordless device, where a particular set of batteries is specifically provided for one tool, the batteries are only discharged when that individual tool is used. They are then connected to the charger and left in storage for a relatively long period of time. This contributes to the slow deterioration of the batteries. In contrast, with the tools described above, the single power handle 12 or 12' can be used with any one of a number of tool heads. Accordingly, a user can remove the handle 12 or 12' from the charger each time he has a need for any one of the respective tool heads and the batteries will be more frequently discharged and charged, thus enhancing their total life expectancy.

From the foregoing, it will be apparent that the modulator tools described give rise to a variety of previously unobtainable advantages. In particular, the modular system is of substantial benefit to both the manufacturer and the ultimate user of these tools since this system permits substantial economies to both parties. Thus, the manufacturer can produce common elements in substantially greater volume, and the ultimate user, in addition to receiving the benefit of greater volume production also obtains the benefit of not being required to purchase and duplicate expensive elements of the system. In addition to these benefits, it must not be overlooked that the system also provides various advantages in terms of the capability of the tool system. For example, as noted above, greater utilisation of rechargeable batteries significantly increases the expected life of the batteries. Moreover, the extension handle concept, illustrated in connection with a grass shear but also applicable to other tools such as an extensible branch trimmer, provides a significantly more useful device. At the same time, this is accomplished without sacrificing a stable, secure coupling, since the same interconnection means and pilot surfaces are used to mount the respective modules to the extension handle. Furthermore, the particular details of an extended coupling means, a large area pilot surface and the latch for retaining the modules in position are of basic importance in ensuring that the system does, in fact, form a power tool comparable to conventional integral units in rigidity and stability. Finally, in the context of independent modules which must be assembled, the lock-off feature is of particular importance in avoiding the possible safety hazards which ensure where an operator bumps the switch or holds it on during assembly, thus causing immediate energisation of, for example, a bladed or hot tip tool head.

WHAT WE CLAIM IS:—

1. A first module in combination with a second module, the first module comprising a housing having an end abutment

face, a hand grip, a cavity for receiving battery means, terminals for making electrical contact with the battery means when positioned within the housing, first contact means accessible from outside the first housing and a control switch in electrical connection in a circuit including the first contact means and the terminals, and the second module comprising a housing incorporating an electrical appliance and with an end abutment face adapted to mate with the end abutment face of the first module by means of slidably interlocking surfaces on the end abutment faces to hold the modules together and second contact means accessible from outside the second housing, in electrical connection with the electrical appliance and positioned to engage the first contact means electrically when the first and second housings are in mating engagement, the arrangement being such that mating of the end abutment faces is effected by engaging the end abutment faces and the sliding one module relatively to the other in a direction substantially parallel to the end abutment faces thereby engaging the slidably interlocking surfaces.

2. A combination as claimed in claim 1 in which the control switch is operated by a trigger mounted on, and depending from, the housing of the first module.

3. A combination as claimed in claim 1 or 2 in which the end abutment face of each module includes a respective flat pilot surface, which pilot surfaces lie in face to face engagement when the two modules are assembled together.

4. A combination as claimed in claim 3 in which each pilot surface extends substantially across the entire end of its module.

5. A combination as claimed in any preceding claim in which the first module is provided with lock-off means for preventing operation of the switch.

6. A combination as claimed in claim 5 in which the lock-off means is biassed towards the position in which it prevents operation of the switch.

7. A combination as claimed in any preceding claim in which the interlocking surface of one of the modules is a tenon and the interlocking surface of the other module is a groove.

8. A combination as claimed in claim 7 in which the groove is undercut in cross-section.

9. A combination as claimed in any preceding claim further comprising a latch means for holding the two modules together in their assembled position.

10. A combination as claimed in claim 9 in which the latch means comprises a latch member slidably mounted in one of the modules and an aperture in the other module, the latch member and the aperture being so located as to be aligned when the two modules are assembled such that the latch member may be received in the aperture.

11. A combination as claimed in claim 10 in which the latch member is spring biassed towards the aperture when the two modules are assembled together.

12. A combination as claimed in claim 5 or claim 6 in which the lock-off means comprises a lock-off member pivotally mounted within the housing of the first module, one end of the lock-off member being pivotable to the position in which it prevents operation of the switch, the other end of the lock-off member extending externally of the housing of the first module.

13. A combination as claimed in claim 12 in which a lock-off button is provided at said other end of the lock-off member.

14. A combination as claimed in claim 12 or claim 13 in which the switch is movable between a first, "off" position and a second, "on" position via a third, intermediate position, the lock-off member normally preventing movement of the switch from its first position but being prevented form moving into the path of the switch when the switch is in its third position, and wherein the lock-off member is provided with a tapered stop along a side surface thereof to define the location of the third position.

15. A combination as claimed in any one of claims 12 to 14 in which the second module is provided with a tapered rib extending therefrom for automatically disengaging the lock-off member as the two modules are assembled together.

16. A combination as claimed in any one of claims 1 to 6 and 12 to 15 in which said interlocking surface of one of the modules comprises a pair of laterally spaced, outwardly facing ribs and the interlocking surface of the other module comprises a pair of slots.

17. A combination a claimed in claim 16 in which the width of each rib tapers towards one end thereof, both ribs tapering in the same direction.

18. A combination as claimed in claim 17 in which the thickness of each rib, in a direction perpendicular to that of the lateral spacing of the ribs, tapers in a similar manner to its width.

19. A combination as claimed in any one of claims 16 to 18 when appendant to claim 3 in which the ribs of said one module are aligned in a plane disposed at an angle to the pilot surface of that module, the slots of said other module being aligned in a plane disposed at the same angle to the pilot surface of that module.

20. A combination as claimed in claim 19

in which said angle lies in the range of from 4° to 7°.

21. A combination as claimed in any one of claims 1 to 6 and 12 to 20 further comprising a latch means for holding the two modules together in their assembled position.

22. A combination as claimed in claim 21 in which the latch means comprises a latch member pivotally mounted to one of the modules and a shoulder provided on the other module, the latch member and shoulder being so located that, as the two modules are assembled together the shoulder engages the latch member and, when the modules are fully assembled, the latch member engages behind the shoulder.

23. A combination as claimed in claim 21 in which the latch member is spring biassed towards its position of engagement with the shoulder when the two modules are assembled together.

24. A combination as claimed in any of claims 1 to 6 and 12 to 23 in which the first contact means comprises three electrical contacts, in which a pair of the contacts are connected to respective terminals and the switch is arranged to connect one of the pair of contacts to the third contact.

25. A combination as claimed in claim 24 when appendant to claim 3 in which said three contacts are exposed within the pilot surface of the first module.

26. A combination as claimed in claim 24 or 25 in which each of said three contacts comprises a respective elongated strip of metal having one end disposed within the housing of the first module. 27. A combination as claimed in claim 26 in which the switch comprises a finger-engageable trigger and a conductive element mounted thereon, the conductive element being arranged to bridge said one end of said third contact and said one end of said one of the pair of contacts.

28. A combination as claimed in claim 27 in which the trigger comprises a body having a T-shaped rib on one end thereof, and wherein the conductive element is provided with a T-shaped slot for engagement with the T-shaped rib.

29. A combination as claimed in claim 29 wherein the conductive element is prestressed to provide a spring force to maintain the conductive element in firm contact with said contact ends when the switch is in its "on" position.

30. A combination as claimed in claim 2 or any one of claims 3 to 6 and 12 to 29 when appendant to claim 2 in which the housing of the first module forms a four-sided closed loop about a central opening, one of the sides defining a hand grip, the trigger extending from the housing and into the central opening for engagement by an operator having his hand in place on the hand grip, the first contact means and the end abutment face being provided on a second side of the housing.

31. A combination as claimed in any one of claims 1 to 6 and 12 to 30 further comprising an extension arm, one end of the extension arm having an end abutment face provided with a slidably interlockable surface for slidable engagement with the slidably interlockable surface of the first module, the other end of the extension arm having an end abutment face provided with a slidably interlockable surface for slidable engagement with the slidably interlockable surface of the second module, the extension arm also being provided with electrical contact means and circuitry for electrically connecting the electrical device of the second module to the battery means of the first module when the extension arm is assembled to the first and second modules and the switch is operated.

32. A combination as claimed in claim 31 in which that portion of the extension arm which is adjacent the second module when assembled thereto is provided with at least one wheel for providing rolling support for the second module.

33. A combination as claimed in any preceding claim in which the first module further includes battery means constituted by a plurality of rechargeable battery cells.

34. A combination as claimed in any preceding claim in which the electrical appliance of the second module comprises an electric motor and a power-operated tool.

35. A combination as claimed in claim 33, wherein the electrical appliance of the second module is a charging device for the rechargeable battery cells.

36. A first module in combination with a second module, the combination being substantially as herein described with reference to and as illustrated by Figs. 1 to 5 of the accompanying drawings.

37. A combination as claimed in claim 36 modified substantially as herein described with reference to and as illustrated by Figs. 6 and 7, by Fig. 8, by Fig. 9 by Fig. 10, by Fig. 11, by Fig.12 or by Fig. 13 of the accompanying drawings.

38. A first module in combination with a second module, the combination being substantially as herein described with reference to and as illustrated by Figs. 14 to 25 of the accompanying drawings.

39. A combination as claimed in claim 38 modified substantially as herein described with reference to and as illustrated by Fig. 26 of the accompanying drawings.

40. A power handle module comprising a housing having an end abutment face

adapted to mate with an end abutment face of a module incorporating an electrical appliance, a cavity for receiving battery means, terminals for making electrical contact with the battery means when positioned within the housing, contact means accessible from outside the housing for engaging contact means on an electrical appliance module when it mates with the power handle module and a control switch in electrical connection in a circuit including the first contact means and the terminals, wherein the end abutment face of the power handle module is provided with a slidably interlockable surface, the arrangement being such that mating of the end abutment face of the power handle module to an electrical appliance module is effected by engaging the slidably interlockable surface of the power handle module with a corresponding surface on an end abutment face of an electrical appliance module and then sliding one module relative to the other in a direction substantially parallel to the end abutment faces.

41. A power handle module as claimed in claim 40 in which the control switch is operated by a trigger mounted, on, and depending from, the housing.

42. A power handle module as claimed in claim 40 or 41 in which the end abutment face includes a flat pilot surface, which pilot surface lies in face to face engagement with a corresponding surface on an end abutment face of an electrical appliance module when the power handle module is mated with an electrical appliance module.

43. A power handle module as claimed in claim 42 in which each pilot surface extends substantially across the entire end of its module.

44. A power handle module as claimed in any one of claims 40 to 43 in which the module is provided with lock-off means for preventing operation of the switch.

45. A power handle module as claimed in claim 44 in which the lock-off means is biassed towards the position in which it prevents operation of the switch.

46. A power handle module as claimed in any one of claims 40 to 45 in which the interlocking surface is a groove shaped to form the groove part of a tenon and groove connection.

47. A power handle module as claimed in claim 46 in which the groove is undercut in cross-section.

48. A power handle module as claimed in any one of claims 40 to 45 in which said interlocking surface comprises a pair of laterally spaced, outwardly facing ribs.

49. A power handle module as claimed in claim 48 in which the width of each rib tapers toward one end thereof, both ribs tapering in the same direction.

50. A power handle module as claimed in claim 49 in which the thickness of each rib, in a direction perpendicular to that of the lateral spacing of the ribs, tapers in a similar manner to its width.

51. A power handle module as claimed in any one of claims 48 to 50 when appendant to claim 42 in which the ribs are aligned in a plane disposed at an angle to the pilot surface.

52. A power handle module as claimed in claim 51 in which said angle lies in the range of from 4° to 7°.

53. A power handle module as claimed in any of claims 40 to 45 and 48 to 52 in which the contact means comprises three electrical contacts in which a pair of the contacts are connected to respective terminals and the switch is arranged to connect one of the pair of contacts to the third contact.

54. A power handle module as claimed in claim 53 when appendant to claim 42 in which said three contacts are exposed within the pilot surface.

55. A power handle module as claimed in claim 53 or 54 in which each of said three contacts comprises a respective elongated strip of metal having one end disposed within the housing of the first module.

56. A power handle module as claimed in claim 55 in which the switch comprises a finger-engageable trigger and a conductive element mounted thereon, the conductive element being arranged to bridge said one end of said third contact and said one end of said one of the pair of contacts.

57. A power handle module as claimed in claim 56 in which the trigger comprises a body having a T-shaped rib on one end thereof, and wherein the conductive element is provided with a T-shaped slot for engagement with the T-shaped rib.

58. A power handle module as claimed in claim 57 wherein the conductive element is prestressed to provide a spring force to maintain the conductive element in firm contact with said contact ends when the switch is in its "on" position.

59. A power handle module as claimed in claim 41 or any one of claims 42 to 45 and 48 to 58 when appendant to claim 41 in which the housing forms a four-sided closed loop about a central opening, one of the sides defining a hand grip, the trigger extending from the housing and into the central opening for engagement by an operator having his hand in place on the hand grip, the first contact means and the end abutment face being provided on a second side of the housing.

60. A power handle module substantially as herein described with reference to and as illustrated by Figs. 1 to 5 of the accompanying drawings.

61. A power handle module substantially as herein described with reference to and as illustrated by Figs. 14, 15, 17, 19, 20, 21, 22, 23 and 24 of the accompanying drawings.

62. An electrical appliance module comprising a housing incorporating an electrical appliance and having an end abutment face adapted to mate with an end abutment face of a power handle module, and contact means in electrical connection with the electrical appliance and accessible from outside the housing for engaging contact means on a power handle module when it mates with the electrical appliance module, wherein the end abutment face of the electrical appliance module is provided with a slidably interlockable surface, the arrangement being such that mating of the end abutment face of the electrical appliance module to a power handle module is effected by engaging the slidably interlockable surface of the electrical appliance module with a corresponding surface on an end abutment face of a power handle module and then sliding one module relative to the other in a direction substantially parallel to the end abutment faces.

63. An electrical appliance module as claimed in claim 62 in which the control switch is operated by a trigger mounted on, and depending from, the housing.

64. An electrical appliance module as claimed in claim 62 or 63 in which the end abutment face includes a flat pilot surface, which pilot surface lies in face to face engagement with a corresponding surface on an end abutment face of a power handle module when the electrical appliance module is mated with a power handle module.

65. An electrical appliance module as claimed in claim 64 in which each pilot surface extends substantially across the entire end of its module.

66. An electrical appliance module as claimed in any one of claims 62 to 65 in which the interlocking surface is a tenon for forming a tenon and groove connection.

67. An electrical appliance module as claimed in any one of claims 62 to 65 in which the interlocking surface comprises a pair of slots for engaging a pair of laterally spaced, outwardly facing ribs.

68. An electrical appliance module as claimed in claim 67 when appendant to claim 64 in which the slots are aligned in a plane disposed at an angle to the pilot surface.

69. An electrical appliance module as claimed in claim 68 in which said angle lies in the range of from 4° to 7°.

70. An electrical appliance module as claimed in any of claims 62 to 69 in which the electrical appliance comprises an electric motor and a power-operated tool.

71. An electrical appliance module as claimed in any of claims 62 to 69 in which the electrical appliance is a charging device for charging rechargeable battery cells.

72. An electrical appliance module substantially as herein described with reference to and as illustrated by Figs. 1 to 5 of the accompanying drawings.

73. An electrical appliance module as claimed in claim 72 modified substantially as herein described with reference to and as illustrated by Figs. 6 and 7, by Fig. 8, by Fig. 9, by Fig. 10, by Fig. 11, by Fig. 12 or by Fig. 13 of the accompanying drawings.

74. An electrical appliance module substantially as herein described with reference to and as illustrated by Figs. 14, 16, 18, 20, 21, 22, 23, 24 and 25 of the accompanying drawings.

ABEL & IMRAY,
Chartered Patent Agents,
Northumberland House,
303—306 High Holborn,
London, WC1V 7LH.

Printed for Her Majesty's Stationery Office by the Courier Press, Leamington Spa, 1978.
Published by the Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.

1515390 COMPLETE SPECIFICATION
7 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 1

FIG. 1

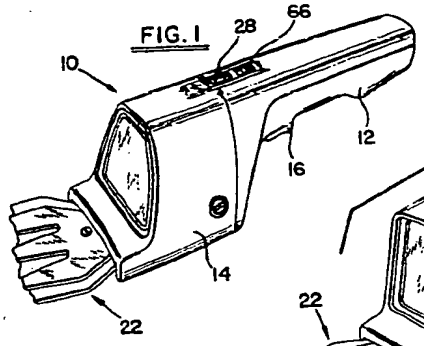


FIG. 2

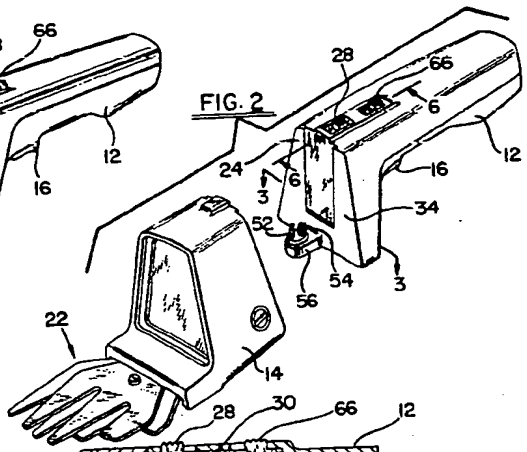


FIG. 3

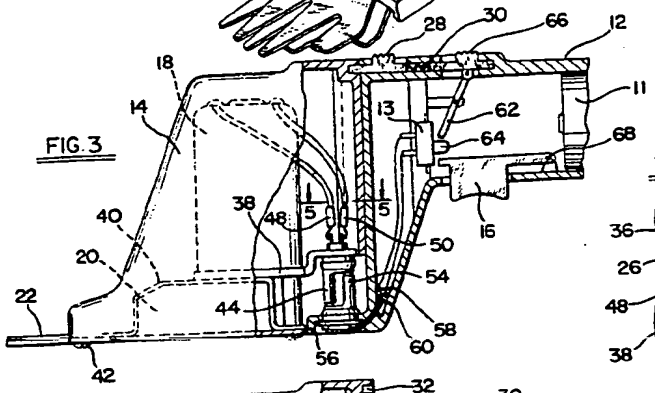


FIG. 5

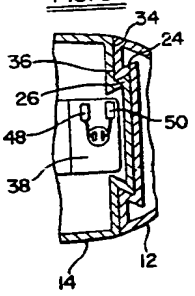
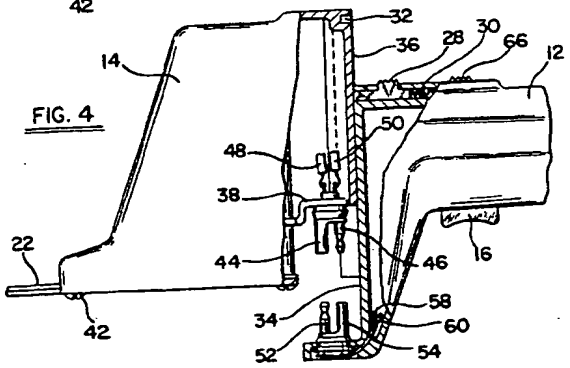


FIG. 4



1515390 COMPLETE SPECIFICATION
7 SHEETS This drawing is a reproduction of the Original on a reduced scale
Sheet 2

FIG. 6

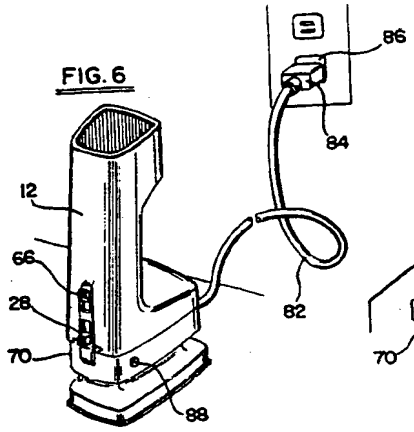


FIG. 7

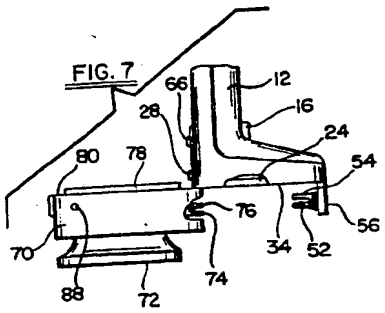


FIG. 8

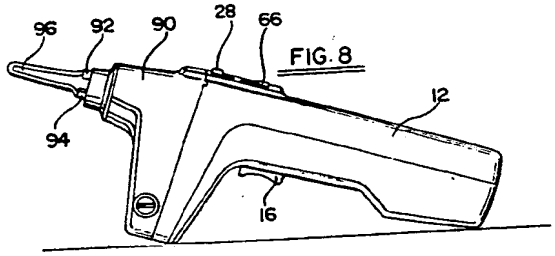
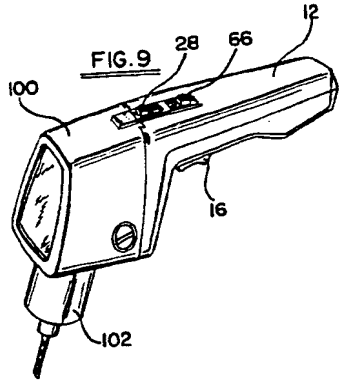


FIG. 9



1515390 COMPLETE SPECIFICATION
7 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 3

FIG. 10

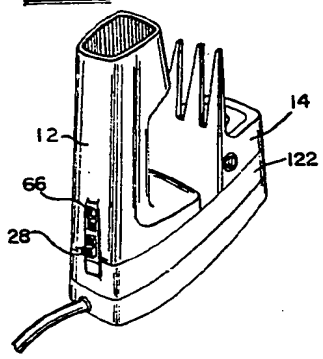


FIG. 11

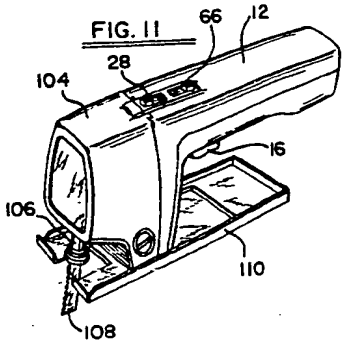


FIG. 12

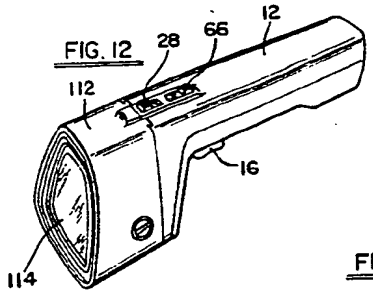
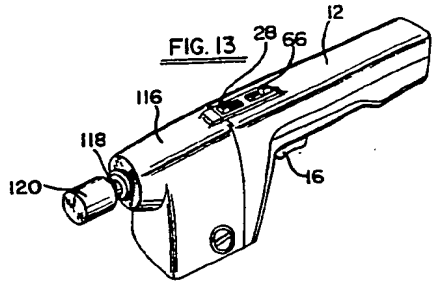


FIG. 13



1515390
7 SHEETS

COMPLETE SPECIFICATION

This drawing is a reproduction of the Original on a reduced scale

Sheet 4

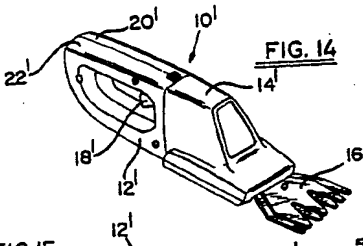


FIG. 14

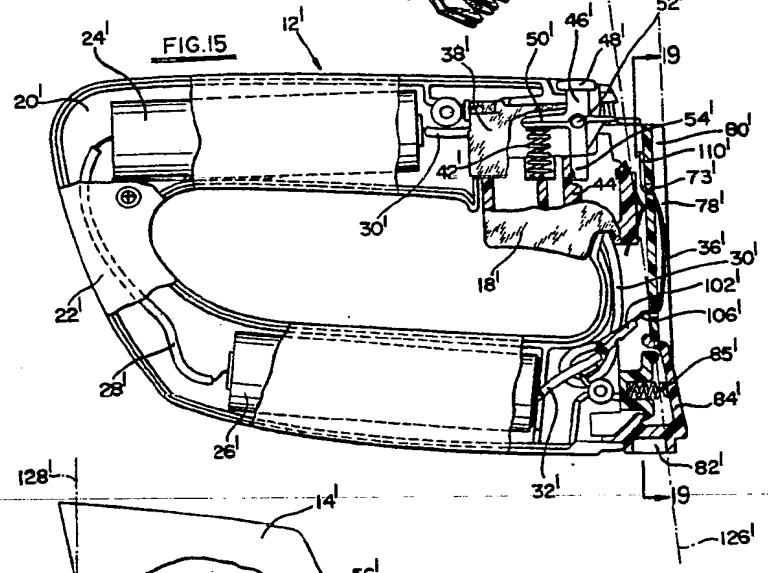


FIG.15

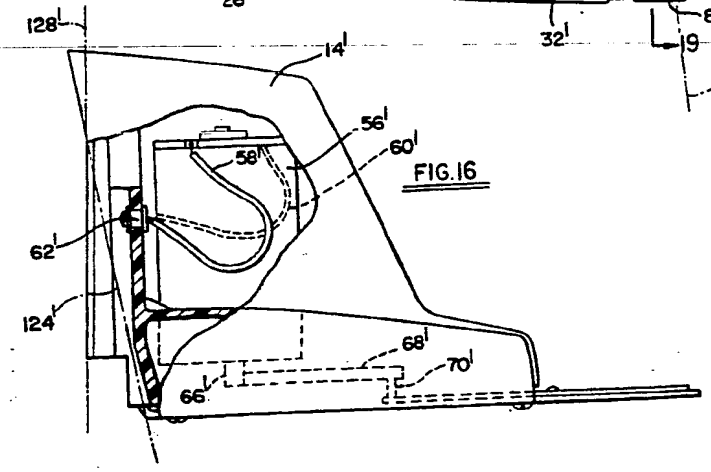


FIG.16

1515390 COMPLETE SPECIFICATION
7 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 5

FIG.17

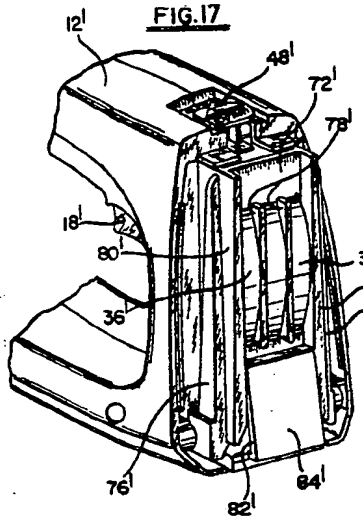


FIG.18

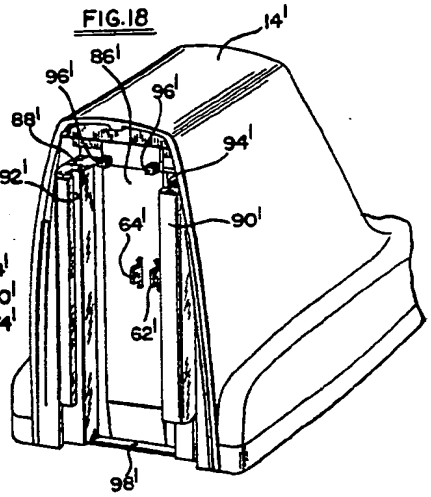
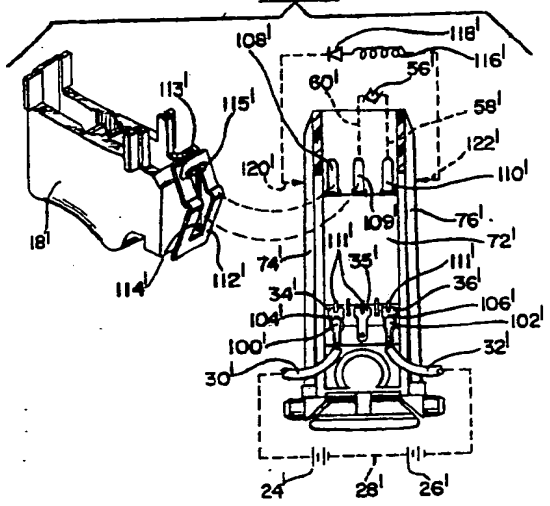


FIG.19



1515390 COMPLETE SPECIFICATION
7 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 6

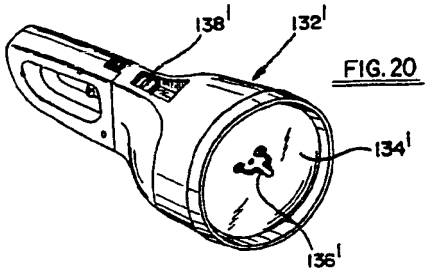


FIG. 20

FIG. 21

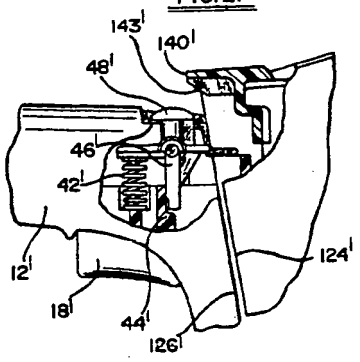


FIG. 22

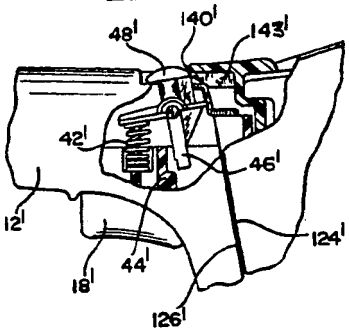
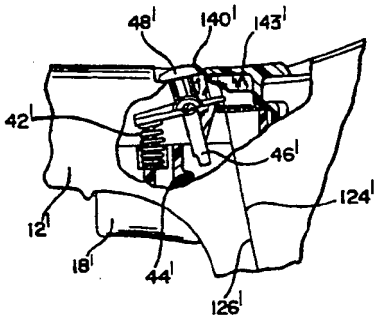


FIG. 23



1515390 COMPLETE SPECIFICATION
7 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 7

FIG.24

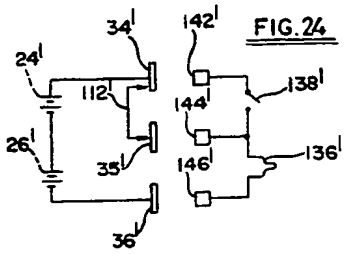


FIG.25

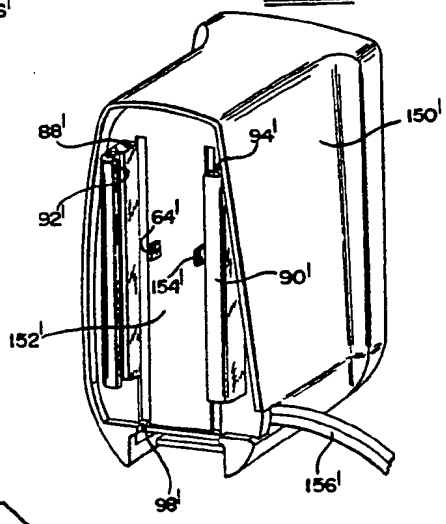


FIG.26